



Principles of HVDC Transmission

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PRINCIPLES OF HVDC TRANSMISSION

The question that is frequently discussed is: "Why does anyone want to use D.C. transmission?" One reply is that electric losses are lower, but this is not true. Amount of losses is determined by the rating and size of chosen conductors. Both D.C. and A.C. conductors, either as transmission circuits or submarine cables can generate lower power losses but at increased cost since the bigger cross-sectional conductors will typically lead to lower power losses but will unfortunately cost more.

When power converters are utilized for D.C. electrical transmission in preference to A.C. electrical transmission, it is commonly impacted by one of the causes:

- An overhead D.C. line with associated overhead line towers can be made as less pricey per unit of length than the same A.C. transmission line made to transfer the equivalent amount of electric power. Nevertheless the D.C. converter stations at transmission line terminal ends are more expensive than the stations at terminals of an A.C. transmission line. Therefore there is a breakeven length above which the overall price of D.C. electrical transmission is lower than its A.C. electrical transmission option. The D.C. electrical transmission line can have a lower visual impact than the same A.C. transmission line, producing lower environmental effect. There are additional environmental advantages to a D.C. electrical transmission line through the electric and magnetic fields being D.C. instead of A.C.
- If transmission is achieved by underground cable, the breakeven length is lower than overhead electrical transmission. It is not feasible to look at A.C. cable installations over 50 km but D.C. cable transmission installations are in operation whose length is in the hundreds of kilometres. Lengths of 600 km or higher have been regarded as practical.

- Certain A.C. electric power networks are not synched to adjacent electrical systems although physical lengths between them is insignificant. This happens in Japan where half the state is a 60 Hz system and the other is a 50 Hz network. It is not possible to link the two subsystems together by direct A.C. installations in order to transfer electric energy between them. Nevertheless, if a D.C. converter station is placed in each subsystem with a D.C. connection between them, it is feasible to transmit the needed power flow although the A.C. networks so connected stay asynchronous.

ARRANGEMENTS

The inherent component of an HVDC power converter station is the valve or valve arm. If it is made from one or more diodes connected in series it is known as non-controllable or controllable if it is made from one or more thyristors connected in series. Graphical symbols for valves and bridges that are set by IEC are shown in Figure 1. The typical bridge or converter link is known as a double-way connection consisting of six valves or valve arms that are linked as presented in Figure 2.

Electric power running between the HVDC valve group and the A.C. network is three phase. When electric power runs into the D.C. valve group from the A.C. network then it is conceived a rectifier. If power runs from the D.C. valve group into the A.C. network, it is an inverter. Each valve comprises of many thyristors linked in series in a form of thyristor modules.

Electric circuit system characterization for the six pulse valve group arrangement is illustrated in Figure 2. The six pulse valve group was typical when the valves were mercury arc.

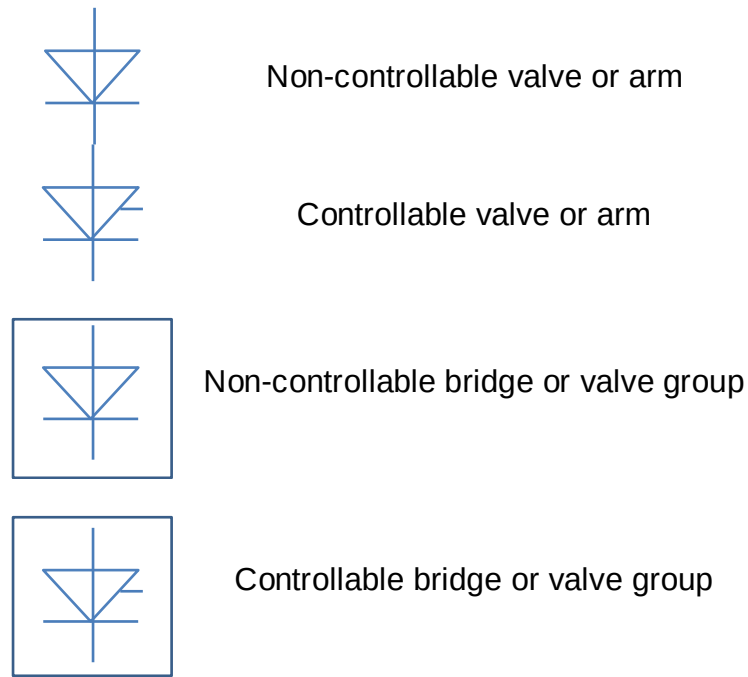


Figure 1. Typical graphical symbols for valves and bridges

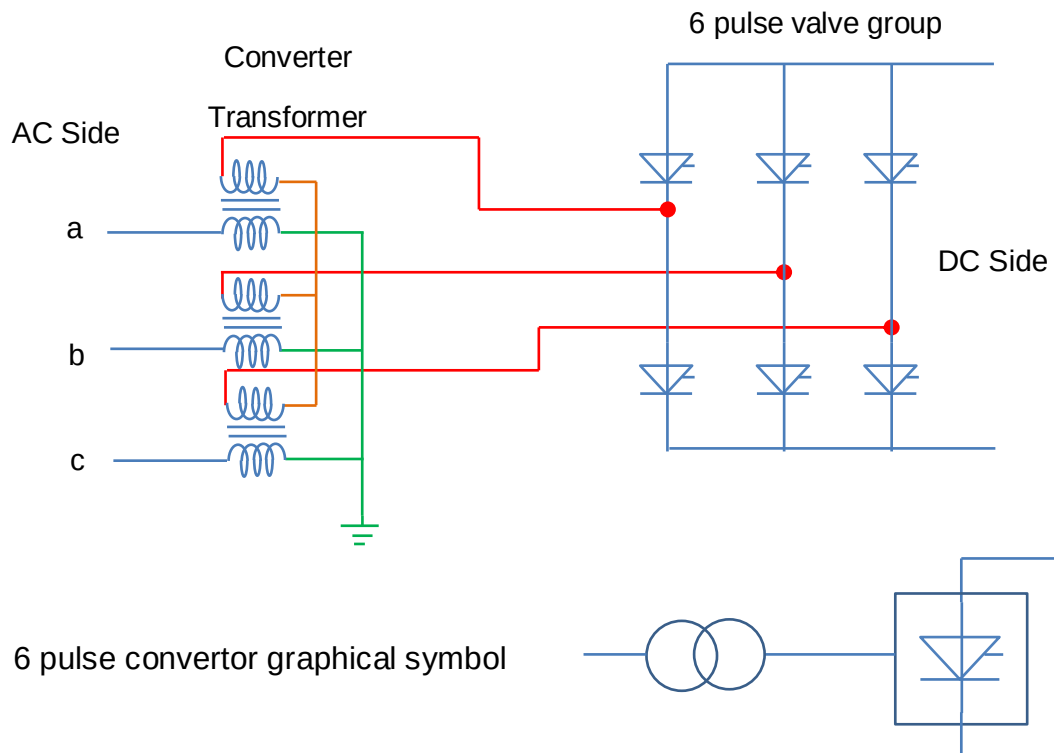


Figure 2. Electric circuit arrangement of the elemental six pulse valve group with converter transformer in star-star arrangement

TWELVE PULSE VALVE ARRANGEMENT

Almost all HVDC power converters that use thyristor valves are set up in a converter bridge of twelve pulse arrangement. The utilization of two three phase converter transformers with one D.C. side winding as an ungrounded star connection and the other a delta configuration is demonstrated in Figure 3. Accordingly, the A.C. voltages put on to each six pulse valve arrangement that make up the twelve pulse valve arrangement have a phase shift of 30 degrees that is used to offset the A.C. side 5th and 7th harmonic currents and D.C. side 6th harmonic voltage, hence ensuing in a substantial sparing in harmonic filters. Outline around each of the three arrangements of four valves in a single vertical stack is also presented in Figure 3. These are cognized as “quadrivalves” and are gathered as one valve arrangement by putting four valves in series. Since the voltage rating of thyristors is few kV, a 500 kV quadrivalve may consist of hundreds of individual thyristors arranged in series groups of valve or thyristor modules. A quadrivalve for a high voltage converter is pretty high and may hang freely from the ceiling of the valve hall, particularly in locations sensitive to earthquakes.

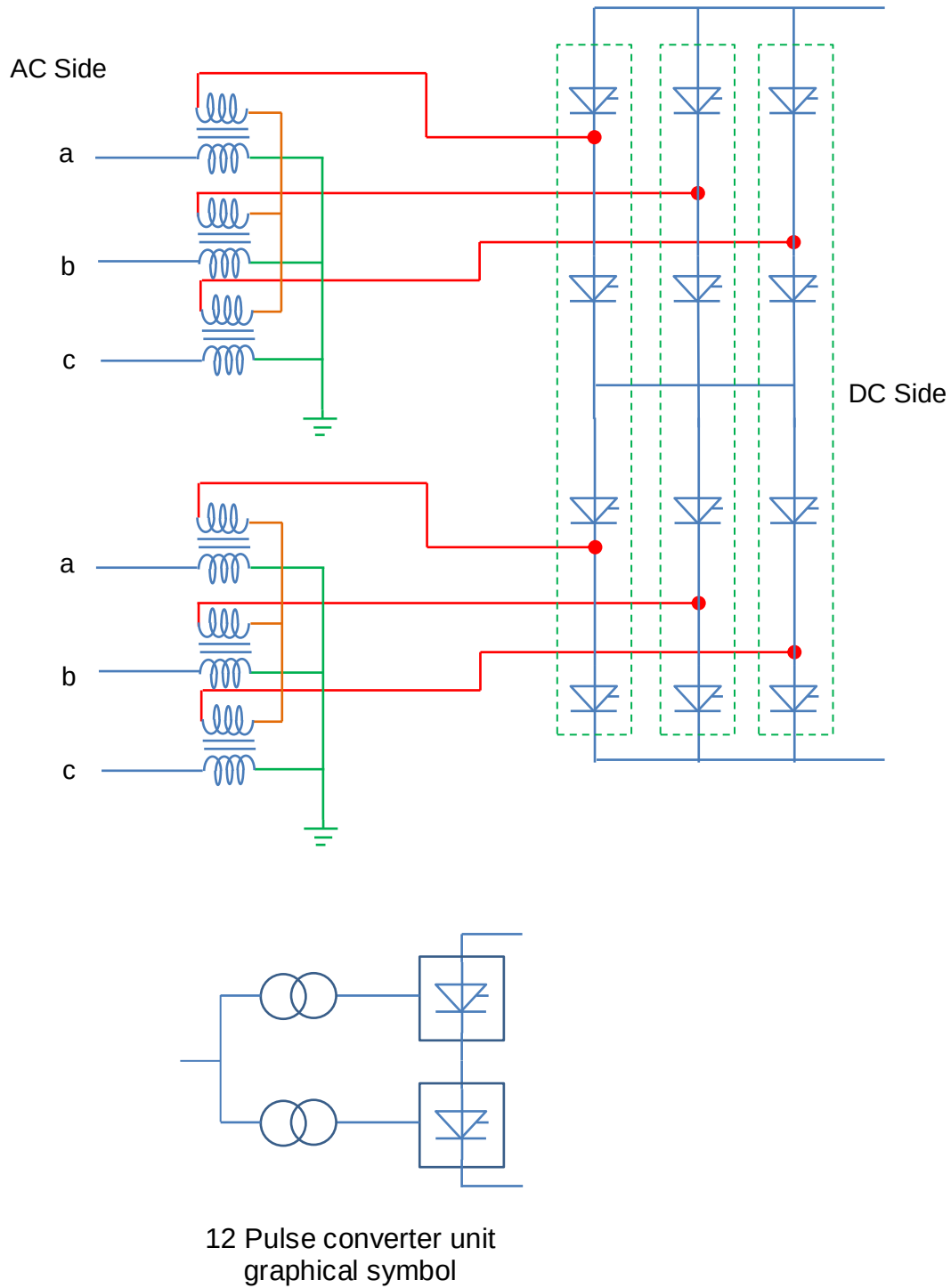


Figure 3. The twelve pulse valve group arrangement with two converter transformers



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